because the rules governing off-axis power density are power-per-bandwidth rules.[82] Although the Commission states that it is not seeking comments on the average-power proposal, that proposal remains the most general and simplest one available.

Indeed, the Commission has, in other contexts, accepted the use of time-averaging to characterize the effects of interference.[83] In its *NGSO Order,* the Commission amended Section 25.208, "Power Flux Density Limits," to add time-averaged power flux density limits for NGSO system interference into GSO FSS systems.[84] Table 1E of this rule employs time averaging to determine acceptable levels of interference in the GSO FSS Ku-Band where VSAT networks operate. For example, for a 1.2 meter VSAT antenna there are nine entries for the "Percentage of time during which $EPFD_{down}$ may not be Exceeded," where $EPFD_{down}$ is the NGSO equivalent power flux density interference in the space-to-earth link. This "percentage of time" method of specifying NGSO interference into GSO systems is equivalent to time averaging TDMA/ALOHA collisions from VSAT transmissions.

Since the Commission has accepted the legitimacy of determining whether interference will result using a time averaging methodology and since the VSAT industry agrees that the Hughes' proposal is acceptable and will not result in any adverse effect on service, the Commission should adopt that proposal.

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[82] *See* Section II.D.4 *supra.*

[83] *See NGSO Order.*

[84] See 47 C.F.R. § 25.208(e) (2001).

III. <u>Other Proposed Rules</u>

A. The Commission Should Define Wideband & Narrowband

In the *Notice*, the Commission requests comment on the use of the terms "wideband" and "narrowband" in Part 25 for analog and digital carriers.[85] Spacenet/StarBand believe that these terms are not adequately defined in the current rules. Additionally, we believe that, if clarified, these terms will prove valuable to the Commission and to the satellite industry. Typically, large-bit-rate digital carriers now provide the video transmissions formerly provided by FM modulated analog carriers in the 1980s and early 1990s when the current rules were written. Additionally, today's large-bit-rate digital carriers also provide new multimedia services, such as Internet access, that were not available when the current rules were established. Since these large-bit-rate carriers typically require higher power densities, on the order of the wideband analog carriers, a distinction between low and high bit rate digital carriers is needed. The Commission's proposal to define them appears reasonable and therefore, Spacenet/StarBand support the Commission's proposed definitions for "full transponder," "wideband," and "narrowband" as set forth in proposed Section 25.201.

B. The Commission Should Adopt Its Proposed Coordination Period

In its *Notice,* the Commission proposes to establish a 60-day deadline after publication of the acceptance for filing of an application for resolving coordination issues among interested parties. Under this proposal, the Commission would act "upon the earth station to communicate at its requested higher power levels with all satellites for

[85] *See Notice* at ¶ 41.

which it has submitted affidavits, and for which there are no unresolved objections to the application."[86]

Spacenet/StarBand support this proposal since it will facilitate the grant of unopposed applications and allow the partial grant of applications that require further coordination. However, this proposal is a relatively minor improvement over current practices, especially since there is no automatic grant or other assurance that the Commission will act expeditiously. Thus, while this proposal may prevent an obstreperous party from unduly delaying the grant of an authorization to the extent that the application does not affect that party, it does not give applicants any assurance that applications will be granted in a timely manner; nor will it permit the Commission to avoid using the current process of granting STAs to permit prompt institution of service.

In a footnote in the original *Notice*, the Commission implied that it would grant applications within 10 days after the end of this sixty day coordination period. Spacenet/StarBand thought that such an automatic grant period, with the Commission retaining the power to stop a grant where it thought there was a question or problem, was extremely beneficial. We continue to believe that some automatic grant period is in the public interest and urge the Commission to adopt such a process. The Commission can facilitate that process by establishing a list or register of acceptable sub-meter antennas such that applicants proposing to use one of those antennas in accordance with

[86] *Notice* at ¶ 35.

specifications in the list or register would be presumed compliant and thus granted automatically unless the Commission took action to halt operation.[87]

C. The Commission Should Adopt the Proposal to Require Applicants to Submit Additional Public Notice Information

Spacenet/StarBand support the proposed modification of Section 25.130(a) to require applicants to provide an "informative" for the public notice. Giving the staff additional information that can be inserted into the Public Notice or posted on the Commission's Home Page should facilitate the processing of non-compliant antennas, as well as give interested parties sufficient information to determine whether the application is likely to cause interference. By requiring the applicant to provide the information, the Commission will ease the burden on its staff and hopefully enable the staff to process applications more expeditiously.

D. The Commission Should Allow Temporary Fixed Earth Stations to Commence Operation on Public Notice and Include in VSAT Licenses

Spacenet/StarBand support the proposals in Sections IV.B and V.D of the *Notice* to allow Temporary Fixed Earth Stations to begin operating once the applications are placed on public notice and to include them in VSAT network licenses. These proposals may allow operators to provide or restore service in emergency situations more quickly, and to use these stations more flexibly, without any harmful effects.

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[87] *See* In the Matter of Inquiry into the Commission's Policies and Rules Regarding AM Radio Service, Directional Antenna Performance Verification, *Notice of Proposed Rulemaking*, 14 FCC Rcd. 9275 (1999).

E. Electronic Filing Should Not Be Required Until the Commission's Electronic Filing Systems Have Been Fully Proven

Spacenet/StarBand support the Commission's proposal to move toward electronic filing, but encourage the Commission to ensure that the system is fully functional before making electronic filing mandatory. In our experience, a number of operational difficulties with the system to date have prolonged the process of filing and approving applications, and have often required the active intervention of FCC personnel to remedy. The system is sometimes unavailable; it sometimes will not work with certain browser software commonly used by applicants; and it has had trouble accepting the quantity of data necessary to describe a large network with multiple sites and antennas. If one accidentally creates an unnecessary extra form section, the system does not allow the applicant to delete it.

No doubt these teething problems can be resolved; however, given the importance of prompt action on applications for VSAT authorizations, Spacenet/StarBand believe that the Commission should be confident of its electronic processing capabilities before requiring parties to use them. Until it is absolutely clear that that capability is in place, applicants must retain the option of filing on paper to ensure that they can meet the deadlines imposed by their business plans. In this respect, Spacenet/StarBand assume that the International Bureau will introduce mandatory electronic filing gradually as a product of a consultative process with the industry to ensure a smooth, effective transition.[88]

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[88] *See, e.g.* Wireless Telecommunications Bureau Recommends Licensees Take Steps to Prepare for Electronic Filing, *Public Notice*, DA 99-1228 (released June 23, 1999); Wireless Telecommunications Bureau Announces Enhancement to Ship Station Licensing Within Universal Licensing System: Change of Vessel Name is Made Under Administrative Update, *Public Notice,* DA 01-0681 (released Mar. 14, 2001).

F. The Commission Should Require the Submission of Antenna Gain Patterns for Non-routine Earth Station Licenses

Spacenet/StarBand support the proposal to require earth station applicants proposing to use non-compliant antennas to submit radiation patterns for the proposed antennas.[89] We note that this information generally originates with the antenna manufacturer, and that each antenna model is likely to be used by a number of licensees. To avoid needless duplication of radiation patterns, we propose that the Commission maintain a database of patterns either of previously-approved antennas or of antennas that manufacturers have submitted to the Commission. Such antennas would be assigned a file number by the Commission, after which applicants would simply indicate the file number rather than actually submit patterns. This will provide substantial efficiency gains, because the antenna plots often run 30 pages or more. If an applicant submits them on paper, it may delay an otherwise-electronic filing. On the other hand, if each applicant submits them as electronic files, the attachments would occupy an enormous amount of storage space on the FCC's computer system.

G. Other Proposals The Commission Should Adopt

In addition to these proposals, Spacenet/StarBand fully support the following other proposed changes, essentially for the reasons set forth in the *Notice:* (a) extending the license term to 15 years; (b) to allow multiple hub stations under a single blanket VSAT license;[90] (c) to modify the rules to conform with the policies adopted in the Commission's DISCO Orders, (d) the proposal in Section VII.D of the *Notice* for

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[89] *See, Notice* at ¶¶ 25–26.

[90] We note that this is merely a clarification of existing policy, which reflects the needs of network administrators to have backup systems and to spread their traffic load for greatest efficiency.

resolving harmful interference, (e) to extend the power limits of Sections 25.211 and 25.212 to other FSS bands, and (f) the proposal to eliminated outdated rules.

CONCLUSION

For the reasons set forth above, Spacenet/StarBand support the Commission's proposals to streamline the application process and to facilitate the prompt grant of applications for VSAT facilities. We are concerned, however, that many of the proposals in this *Notice* are not procedural changes, but rather proposals to change the substantive rules applicable to the VSAT industry. These proposed changes would impose more stringent regulations on the industry than are currently in place and impair not only the continued vitality of existing VSAT services, but also impose substantial burdens on new and innovative satellite-based services that are uniquely capable of serving rural, remote, and unserved segments of the population that would not otherwise be served.

The threat to these new services is inconsistent with the Congressional mandate to foster new technologies and with the Commission's own goals to reaching rural and underserved areas. Since there is absolutely no evidence that the current practices which these proposed rules would modify are causing harmful interference or other harms, and since there is no engineering evidence that an increase in the number of sub-meter antennas will result in such harm, there is no basis for the Commission to thwart the desirable advances which the VSAT industry has been making under the aegis of the existing rules on the speculation that harm may result. The self-interests of the players in the industry to provide high quality services that are competitive with those of landline competitors will provide adequate assurance that there is no material degradation, if any, in the service offered by satellite systems.

Respectfully submitted,

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A

Exhibit A

Explanation of the Impact of the Proposed Power Density Limits on VSAT Services

Spacenet/StarBand believe that the VSAT industry will be harmed unnecessarily if the Commission's proposed power density limit for non-compliant antennas is implemented; all the more so if the Commission were also to adopt the proposed access scheme limitations discussed in Section V.B and Appendix E of the *Notice*. If either of the Commission's proposals were adopted, the proliferation of broadband services to the consumer via GSO FSS would be severely limited. For these broadband services, which are uniquely capable of serving otherwise unserved and underserved Americans, to be economically viable and expeditiously implemented, the consumer market must be served by sub-meter antennas and industry-proven VSAT technology utilizing TDMA/ALOHA access schemes. The Commission is proposing to limit networks employing a TDMA/ALOHA access scheme to an antenna input power spectral density (PSD) of −17 dBW/4kHz, a 3 dB reduction from the current value.[1]

The table below demonstrates the adverse effects of the Commission's proposals on a typical sub-meter VSAT system using the TDMA/ALOHA access scheme. The table assumes that a typical non-compliant 0.85 meter earth station[2] is configured to provide a 150 kbps inbound data rate, a typical value for today's broadband marketplace. This earth station would be required to reduce its power 5 dB, which is the gain in excess of the 29-25 log theta envelope that it exhibits 1.25° off axis.[3] This power reduction will reduce the bit rate to only 47.4 kbps —

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[1] *See* Sections 25.134 and 25.212

[2] *See Notice*, Appendix A, Figure 12.

[3] *See ibid.*

less than that of a 56k telephone modem — which would not be competitive in the broadband marketplace. If, in addition to the 5 dB power reduction imposed on the non-compliant antenna, the Commission were to impose a 3 dB reduction for the TDMA/Aloha access scheme, the system would only support a 18.9 kbps data rate.

Additionally, the table's last row shows that the spectrum efficiency will be reduced by a factor of eight with the Commission's proposed off-axis EIRP rules. Because space segment is a major cost element of a broadband satellite system, increasing costs by a factor of eight may render GSO FSS broadband systems economically unviable.

See next page for Table 1

Table – Impact Evaluation of Commission Transmit Power Related Proposals

Parameter	Evaluation of 0.85 meter Off-Axis EIRP PSD Beginning at 2° and Current Antenna Input PSD	Evaluation of 0.85 meter Off-Axis EIRP PSD Beginning at 1.25° and Current Antenna Input PSD	Evaluation of 0.85 meter Off-Axis EIRP PSD Beginning at 1.25° and Commission Proposed Maximum Antenna Input PSD for TDMA / ALOHA	Units
I. Reduction in Antenna Input PSD				
Due to Antenna Pattern of 0.85 meter (see Appendix A, Figure 12 of NPRM)	0	5	5	dB
Due to FCC Proposed Restrictions on TDMA / ALOHA Access Schemes	0	0	3	dB
Total Power Limitation	0	5	9	dB
II. Antenna Input Power Spectral Density	-14	-19	-23	dBW/4kHz
III. Example of Implementation Impact				
Bit Rate	150	47.4	18.9	Kbps
Bit Rate per Unit Bandwidth	625	197.5	78.7	kbps/MHz

Notes: The Bit Rate per Unit Bandwidth calculation assumes 240 kHz for all cases. For the 150 kbps case 2.4 watts of transmit power per carrier is assumed to provide the current FCC maximum –14 dBW/4kHz antenna input power spectral density for 240 kHz of bandwidth. For the 47.4 kbps case the power is reduced by the 5 dB antenna pattern factor to 0.75 watts per carrier and –19 dBW/4kHz antenna flange density. The 18.9 kbps case the power is reduced by the 9 dB factor to use a transmitter of 0.3 watts at a flange density of –23 dBW/4kHz. For the 150 kbps case the 240 kHz of allocated bandwidth is a typical bandwidth assigned for a carrier with this information rate using QPSK modulation and a ½ rate coding. PSD = power spectral density.

B

Exhibit B

Technical Analysis Supporting Revision of Downlink EIRP Density Rules

This exhibit provides the supporting technical analysis to the Spacenet/StarBand recommended revision of the downlink EIRP spectral density Rules of § 25.134 & 25.212. This exhibit demonstrates that the Spacenet/StarBand proposed modification properly utilizes the technological advancements in the satellite industry and efficiently utilizes the limited available spectrum resources, while maintaining acceptable levels of interference isolation.

This exhibit uses the terms "wideband" and "narrowband" as proposed by the Commission in the *Notice* at Appendix B, § 25.201.

(i) Technological Advances and Link Degradation due to NGSO Interference

Spacecraft and earth station technology advancements since the establishment of the current power spectral density rules have enabled improvements in the utilization of the available Ku-Band resources as summarized below:

Satellite Technology Advances:

- Amplifier Output Power Improvement
- Increased Number of Transponders per Satellite – Reduced Bandwidth Transponder
- Multi-Beam Coverage

Earth Station Technology Advances:

- Improved Earth Station G/T (provided by lower noise temperature LNA/LNBs)
- VSAT RF Electronics Performance and Manufacturing Improvements
- Digital Modem Advances
    a) Forward Error Correction (FEC) Improvements
    b) Reduced Bandwidth Modulation Schemes
    c) High Bit Rate (50 Mbps and higher)

The recent FCC Order FCC 00-418 provides NGSO operators authorization to co-use FSS GSO Ku-Band frequencies for their networks. The use of the FSS Ku-Band by NGSO satellites will introduce interference that must be overcome by the established GSO users to maintain the current grade-of-service to their customers. Spacenet/StarBand's analysis revealed that space-to-earth link will be effected the greatest by the NGSO interference as shown in the table below.

Table B.1 - Typical Downlink Degradation Due to Maximum NGSO Interference

Item No.	Parameter Description	Outbound Value	Inbound Value	Units	Notes
1	C/N_0 Thermal	89.6	64.0	dB-Hz	without NGSO interference
2	C/I_0 Total	90.8	66.2	dB-Hz	without NGSO interference
3	C/N_0 Total	87.1	61.9	dB-Hz	without NGSO interference
4	C/I_0 $NGSO_{downlink}$	92.8	61.4	dB-Hz	NGSO interference contribution
5	C/N_0 Total $_{w/C/I_0\ NGSO}$	86.1	58.6	dB-Hz	total w/NGSO interference
6	Link Degradation	1.0	3.3	dB	due to NGSO interference
7	Required Satellite EIRP Increase	3.1	(see note 2)	dB	increase to counteract NGSO interference

Note: 1. NGSO interference contribution as per maximum $EPFD_{down}$ of −160 dBW/m² in a 40 kHz reference bandwidth as per FCC 00-418, page 149, Table 1E. See Exhibit B of this document.
2. No increase in satellite EIRP can overcome the link degradation caused by the NGSO interference due to the large degradation.

(ii) Downlink EIRP spectral Density for Wideband Digital Carriers

Ku-Band satellite performance improvements have enabled per transponder peak EIRP to increase by approximately 7 dB from a 1980's technology. Satellites supporting full CONUS coverage launched in the 1980's and early 1990's provided a beam peak EIRP of 45 dBW compared to today's state-of-the-art satellite that deliver a 52 dBW beam peak EIRP.[1] The current day satellite has higher payload capacity that allows for the satellite transponder bandwidth to be reduced to 36 MHz. The reduced bandwidth will increase the downlink EIRP spectral density by the ratio of the bandwidth reduction, e.g. a factor of 1.8 dB for a reduction from 54 to 36 MHz, ($10 \times \text{Log}_{10} [54 \div 36] = 1.8$ dB). Table B.1 shows the maximum interference induced by NGSO systems into the outbound downlink (hub to VSAT space-to-earth link) will degrade typical links by 1 dB. It can be shown that this degradation can be overcome in the outbound link by increasing the satellite EIRP by 3 dB (an increase greater that 1 dB is required because the relationship between the satellite EIRP and the C/No Total that has been degraded is not linear).

Earth station technology advances have enabled full transponder operation using high bit rate digital transmissions from VSAT network hubs for distribution of digital video, Internet access and other broadband applications. Therefore, for full transponder operation of wideband digital carriers these factors add to increase the downlink EIRP spectral density as follows (note the transponder bandwidth reduction factor is not included below):

[1] Gstar series satellites built in the 1980's and early 1990's had a saturation beam perk EIRP of 45 dBW per 54 MHz transponder. Current state-of-the-art Ku-Band satellites, such as the GE Americom GE series built in the late 1990's and 2000 operate with a saturated beam peak EIRP of 52 dBW per 36 MHz transponder.

+6	dBW/4k Hz	Current downlink EIRP density specification for digital carriers
+7	dB	Increase due to state-of-the-art satellite EIRP performance
+3	dB	Increase to compensate for NGSO interference
+16	dBW/4k Hz	Total – equals the proposed downlink EIRP density specification for wideband digital carriers in full transponder mode of operation

The current downlink EIRP spectral density specification for analog carriers in § 25.134 & 25.212 is +13 dBW/4kHz, or 3 dB less than the Spacenet/StarBand proposed +16 dBW/4kHz for wideband digital carriers. Wideband digital carriers have a constant spectrum envelope that provides a uniform power spectral density across the transponder bandwidth. However, full transponder analog transmissions via satellite utilize FM modulation, which is not well behaved in terms of its power spectral density distribution across the transponder bandwidth. Therefore, the downlink interference realized by earth stations from a wideband digital carrier operating at a downlink EIRP spectral density of +16 dBW/4kHz with uniform distribution is less than that introduced by an analog carrier operating at +13 dBW/4kHz. Spacenet/StarBand's recommendation is then to authorize wideband digital carriers to operate at a downlink EIRP density of +16 dBW/4kHz with prior coordination provided by satellite operators for use of the capacity by wideband digital or analog carriers.

(iii) Downlink EIRP Spectral Density for Narrowband Digital Carriers

Traditionally operation of a satellite transponder with many narrowband digital carrier assignments is know as operation of the transponder in "multi-carrier mode".[2] For these transponders the total power used by all carriers in the transponder is "backed-off" from saturation to ensure adequately low levels of intermodulation products, which degrade link margins, when the transponder is operated in multi-carrier mode. This "back-off" at the output of the transponder is known as the transponder total "OPBO" (output back-off). Typically the satellite industry sets the OPBO for a transponder operated in multi-carrier mode to 4 dB. This value has been determined to provide the satellite or network operator the optimum link performance and transponder utilization.

With the transponder's power distributed uniformly across the available transponder bandwidth the downlink EIRP spectral density can be determined by using the below formula:

$$\text{D/L EIRP Density (dBW/4kHz)} = \text{Maximum Saturated EIRP (dBW)} - \text{OPBO (dB)} - 10 \times \text{Log}_{10}\,[\text{Transponder Bandwidth (kHz)} \div 4\,]$$

[2] Transponders operated in multi-carrier mode can have tens to hundreds of carrier assignments per transponder.

As discussed previously, today's state-of-the-art Ku-Band satellites have a maximum saturated EIRP of 52 dBW and a bandwidth of 36 MHz. Therefore, the downlink EIRP density for the typical high power Ku-Band satellite transponder operated in multi-carrier mode is:

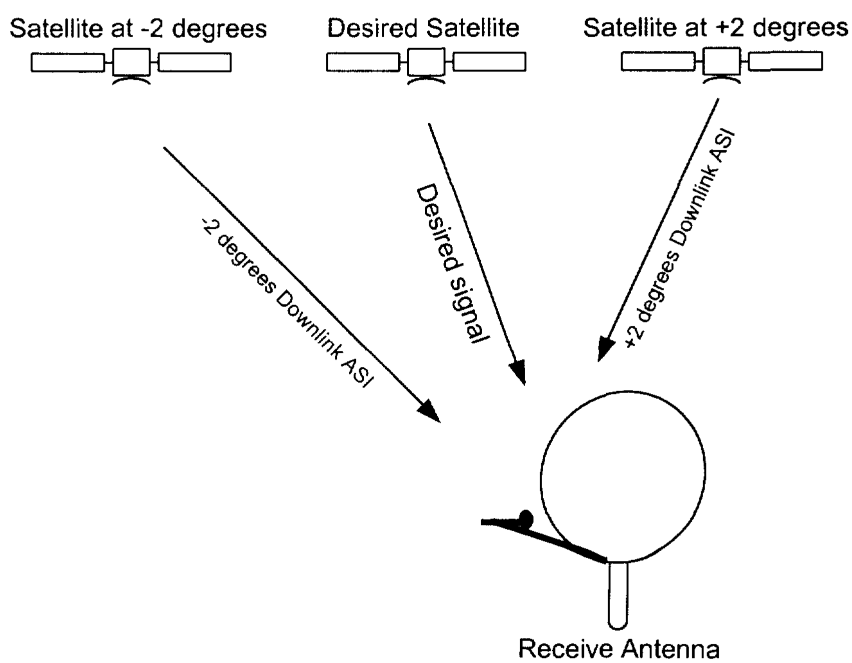
D/L EIRP Density = 52 dBW – 4 dB – 10 x Log_{10} [36,000 ÷ 4] = 8.5 dBW/4kHz

The NGSO interference experienced by narrowband carriers can be expected to be between that shown for the outbound and inbound columns of item number 6 of Table C.1. It was shown previously in this exhibit that at least a 3 dB increase in satellite EIRP is required to overcome expected maximum NGSO generated interference. Therefore, Spacenet/StarBand recommends increasing the downlink EIRP spectral density from +6 dBW/4kHz to +9 dBW/4kHz. The below analysis supports the Spacenet/StarBand proposed modification of the downlink EIRP spectral density specification to 9 dBW/4kHz for narrowband digital carriers.

(iv) Downlink Adjacent Satellite Interference Analysis for Narrowband Carriers

This analysis will present a rigorous interference analysis to determine the impact of increasing the downlink EIRP spectral density specification. The downlink adjacent satellite interference (ASI) will be modeled for narrowband digital carriers assuming similar carrier operation has been coordinated on the adjacent satellites. The below figure depicts the desired operational satellite and two interfering adjacent satellites at +/-2 degrees of longitude separation.

Figure B.1 – Downlink Adjacent Satellite Interference Diagram



The model presented for adjacent satellite downlink interference will include the two-degree adjacent satellites shown in Figure C.1 plus satellites at +/-4 and +/-6 degrees. Satellites beyond +/-6 degrees do not contribute significant levels of interference to the link and therefore are not included. A link budget provides calculations to estimate the expected link performance for the given input requirements and interference model assumptions. The interference impact on the link is calculated by determining the carrier-to-interference noise spectral density or "C/Io". Since the interference from the adjacent satellites will use the FCC downlink EIRP density specification, which is relative to the satellite beam peak EIRP, the carrier power will be calculated for the desired satellite at the beam peak EIRP also ("C" in C/Io). This assumes the peak of the interfering satellite beam is coincident with the peak of the desired satellite's beam peak and the satellites have similar beam coverage. The model will also assume similar path losses to the desired and adjacent satellites. Therefore, the formula for the C/Io Downlink ASI is given as follows for each adjacent satellite:

C/Io Downlink ASI (dB-Hz) = [$EIRP_{max}$ – COPBO (dB) + $G_{rx\ e/s}$ (dBi)] – [PSD_{asi} (dBW/Hz) + $G_{rx\ e/s\ asi}$ (dBi)]

Where: $EIRP_{max}$ = Beam Peak EIRP for desired satellite
COPBO = Carrier Output Backoff for desired carrier (dB reduction from peak EIRP)
$G_{rx\ e/s}$ = Beam Peak Gain of the Receive Earth Station Antenna
PSD_{asi} = Power Spectral Density of ASI
$G_{rx\ e/s\ asi}$ = Gain of the Receive Earth Station Antenna Towards Adjacent Satellite, the maximum off-axis antenna gain specification in § 25.209 will be used, 29 – 25 x Log_{10} ( ) dBi, where is the off-axis angle in degrees.

Table B.2 – ASI Interference Calculation

Satellite Longitude Location Relative to Desired Satellite (degrees)	Earth Station Receive Antenna Gain to Adjacent Satellite (dBi) [29-25Log( ) dBi]	ASI EIRP Density at 6 dBW/4kHz		ASI EIRP Density at 9 dBW/4kHz	
		Co-Polarized Interference Density Contribution (dBW/Hz)	Cross-Polarized Interference Density Contribution (dBW/Hz)	Co-Polarized Interference Density Contribution (dBW/Hz)	Cross-Polarized Interference Density Contribution (dBW/Hz)
+2	21.5	-8.5	-18.5	-5.5	-15.5
-2	21.5	-8.5	-18.5	-5.5	-15.5
+4	13.9	-16.1	-26.1	-13.1	-23.1
-4	13.9	-16.1	-26.1	-13.1	-23.1
+6	9.5	-20.5	-30.5	-17.5	-27.5
-6	9.5	-20.5	-30.5	-17.5	-27.5
Subtotal	N/A	-4.6	-14.6	-1.6	-11.6
Total Io	N/A	-4.2		-1.2	

Notes:
1. The subtotal value is the ratio sum total of all ASI contributions for the indicated columns.

2. The total value is the ratio sum total of the co-polarized and cross-polarized ASI individually for the 6 and 9 dBW/4kHz cases.
3. The cross-polarization calculations assume an earth station antenna gain equal to 19 – 25Log( ) dBi as per § 25.209(b).
4. The FCC downlink EIRP density specification of dBW/4 kHz has been converted to dBW/Hz in the table, therefore 6 dBW/4kHz equals -30 dBW/Hz and 9 dBW/4kHz equals -27 dBW/Hz.

The total shown in Table C.2 provides the interference noise power spectral density in the C/Io equation as follows:

$$Io\ (dB/Hz) = PSD_{asi}\ (dBW/Hz) + G_{rx\ e/s\ asi}\ (dBi)$$

Two link budgets follow for a typical DVB T1 carrier (1.544 Mbps) using ¾ rate FEC (with Reed-Solomon coding) from a large earth station to the smallest FCC compliant Ku-Band earth station, a 1.2 meter. The operating point is set on the transponder such that the desired carrier is operating at the same downlink EIRP spectral density as the downlink ASI and no NGSO interference contribution is included. Therefore, the inputs for these two link budgets are the same except for the downlink ASI assumption and the carrier operating point (COPBO). "Link Budget #1" assumes the current § 25.212 and 25.134 downlink EIRP density specification of 6 dBW/4kHz while "Link Budget #2" assumes the Spacenet/StarBand proposed 9 dBW/4kHz levels. Using the link budget maximum satellite EIRP, COPBO and earth station receive gain from the link budgets the C/Io downlink ASI can be calculated using the previously determined "Io" value as follows:

C/Io ASI_{down} when a downlink EIRP density of 6 dBW/4kHz is utilized for both the desired carrier and ASI:

C/Io Downlink ASI = [52.0 dBW – 20.0 dB + 41.7 dBi] – [-4.2 dBW/Hz] = 77.9 dB-Hz

C/Io ASI_{down} when a downlink EIRP density of 9 dBW/4kHz is utilized for both the desired carrier and ASI:

C/Io Downlink ASI = [52.0 dBW – 17.0 dB + 41.7 dBi] – [-1.2 dBW/Hz] = 77.9 dB-Hz

This shows the Spacenet/StarBand proposed 3 dB increase for the downlink EIRP density specification is counteracted by the 3 dB increase in the desired carrier's operating point (3 dB lower COPBO). The link budget results are summarized in the below table that shows the overall link margin, a primary measure of link performance, ***increases by 2.4 dB*** for the 9 dBW/4kHz operating point relative to the current 6 dBW/4kHz specification.

Table B.3 – Downlink ASI Impact Future Link Budgets

	Link Budget #1	Link Budget #2	Differenc e (#2 - #1)	Units
Desired Carrier Downlink EIRP Density	6.0	9.0	3.0	dBW/4kHz
Interference Carrier Downlink EIRP Density	6.0	9.0	3.0	dBW/4kHz
C/Io Downlink ASI	77.9	77.9	0.0	dB-Hz
COPBO	20.0	17.0	-3.0	dB
Overall Link Margin	3.1	5.4	2.3	dB

Impact on Existing Links

The previous analysis showed that increasing the downlink EIRP spectral density to 9 dBW/4kHz for narrowband carriers will allow better utilization of high power satellites by an increase of 2.3 dB in overall link margin compared to a link operating with the current limit of 6 dBW/4kHz. Now the impact of an increased downlink EIRP spectral density specification on existing links will be analyzed. Link Budget #3 of this section provides a typical existing link operating under the current Rules with adjacent satellite downlink interference operating at the Spacenet/StarBand proposed 9 dBW/4kHz. Comparison of Link Budgets #1 and #3 in Table C.4 below shows the impact raising the downlink EIRP density will have on existing links do not changed their operating point to the proposed new downlink EIRP spectral density limit. The below calculation shows the C/Io ASI_{down} when a downlink EIRP density of 6 dBW/4kHz is utilized for the desired carrier and 9 dBW/4kHz is used for the ASI. This value is used in Link Budget #3 for the C/Io ASI_{down}.

C/Io Downlink ASI = [52.0 dBW – 20.0 dB + 41.7 dBi] – [-1.2 dB/Hz] = 74.9 dB-Hz

Table B.4 – Downlink ASI Impact Current Links

	Link Budget #1	Link Budget #3	Difference (#3 - #1)	Units
Desired Carrier Downlink EIRP Density	6.0	6.0	0.0	dBW/4kHz
Interference Carrier Downlink EIRP Density	6.0	9.0	3.0	dBW/4kHz
C/Io Downlink ASI	77.9	74.9	-3.0	dB-Hz
COPBO	20.0	20.0	0.0	dB
Overall Link Margin	3.1	2.4	0.7	dB

This shows that existing links can expect a maximum decrease in overall link margin of 0.7 dB if all adjacent satellites out to +/-6° are operating at the proposed new maximum downlink EIRP spectral density. Given the NGSO interference degradations allowed by the Commission, as shown in Table B.1, this worst case maximum of 0.7 dB degradation to existing links should be tolerable and is only imposed on those links that do not choose to increase their operating point to the proposed new limit.

(v) Conclusion

This exhibit has provided the technical supporting analysis to allow increasing the narrowband and wideband digital carrier downlink EIRP spectral density specified in Part 25 to +16 dBW/4kHz and +9 dBW/4kHz respectively. These levels will enable FSS GSO links sufficient margin to overcome NGSO downlink interference the majority of the time and provide optimum utilization of the Ku-Band FSS GSO resources while maintaining an acceptable interference environment.

The interference model presented here is a worst-case representation of downlink ASI for narrowband digital carriers as typically (i) off-axis antenna gain performance toward two, four and six degree adjacent satellites is better than §25.209 (as documented by the typical antenna patterns for compliant antennas provided in Exhibit A of the NPRM) and (ii) the majority of installations will not have all adjacent satellites with full period carriers all operating at the maximum allowable downlink EIRP density.

LINK BUDGET #1

Adjacent Satellites Operating and Desired Carrier at **6 dBW/4kHz** Downlink EIRP Density

FROM: POINT A

TO: POINT B

Link Requirements

Required Eb/No (dB)	5.50
Modulation Type	QPSK
Information Rate (Kbps)	1544.00
FEC Rate	0.69
Spread Spectrum Factor	1.44
Modem Step Size (kHz)	1.00

Satellite

Satellite	GE-4
Satellite West Longitude	101.00
Transponder	KU
Usable Trnspndr BW (MHz)	36.00
SFD @ 0 dB/K (dBW/M^2)	-92.00
Transponder Atten (dB)	10.00
Beam Peak EIRP (dBW)	52.00

Transmit Earth Station

Frequency (GHz)	14.25
Satellite G/T (dB/K)	5.27
Antenna Diameter (m)	5.60
Antenna Gain (dBi)	57.10
Antenna Elevation (Deg)	38.65
Carrier EIRP (dBW)	55.96
Power Control (dB)	0.00
Output Circuit Loss (dB)	4.00
Path Loss (dB)	207.12
Other Losses (dB)	0.70
(other loss = atm,pol,ant point)	

Receive Earth Station

Frequency (GHz)	11.95
Satellite EIRP (dBW)	50.00
Antenna Diameter (m)	1.20
Antenna Gain (dBi)	41.70
Antenna Elevation (Deg)	38.65
LNA Noise Temp (K)	75.00
Loss betw.LNA & Ant.(dB)	0.20
System Noise Temp. (K)	118.20
Station G/T (dB/K)	20.97
Path Loss (dB)	205.59
Other Losses (dB)	0.60

Interference and Thermal Contributions

C/Io Adj Sat Uplink (dB-Hz)	84.17	C/Io Intermod (dB-Hz)	78.11
C/Io Adj Sat Downlink (dB-Hz)	**77.90**	C/No Thermal Uplink (dB-Hz)	82.01
C/Io Crosspol (dB-Hz)	88.06	C/No Thermal Downlink (dB-Hz)	73.42
C/Io Adj Channel (dB-Hz)	91.67	C/Io Total (dB-Hz)	74.16
C/Io Adj Transponder (dB-Hz)	91.87	C/No Therm Total (dB-Hz)	72.86
C/Io Microwave (dB-Hz)	N/A	C/No Total (dB-Hz)	70.45

Rain Attenuation

Clear Sky Eb/No (dB)	8.56
Overall Link Margin (dB)	**3.06**
Uplink Rain Margin (dB)	3.06
Downlink Rain Margin (dB)	2.00
G/T Degradation (dB)	2.80

Transponder Operation

Number of Carriers	MULTIPLE
Total OPBO (dB)	4.00
Total IPBO (dB)	6.10
Carrier OPBO (dB)	19.96
Carrier IPBO (dB)	22.06

FCC Requirements

Uplink Flange Density (dBW/4kHz)	-27.18
Downlink EIRP Density (dBW/4kHz) at 52 dBW Satellite EIRP	**6.00**

Transponder Utilization

Carrier Bandwidth (MHz)	1.608
Percentage Bandwidth (%)	4.47
Percentage Power (%)	2.54

LINK BUDGET #2

Adjacent Satellites and Desired Carrier Operating at **9 dBW/4kHz** Downlink EIRP Density

FROM: POINT A

TO: POINT B

Link Requirements

Required Eb/No (dB)	5.50
Modulation Type	QPSK
Information Rate (Kbps)	1544.00
FEC Rate	0.69
Spread Spectrum Factor	1.44
Modem Step Size (kHz)	1.00

Satellite

Satellite	GE-4
Satellite West Longitude	101.00
Transponder	KU
Usable Trnspndr BW (MHz)	36.00
SFD @ 0 dB/K (dBW/M^2)	-92.00
Transponder Atten (dB)	10.00
Beam Peak EIRP (dBW)	52.00

Transmit Earth Station

Frequency (GHz)	14.25
Satellite G/T (dB/K)	5.27
Antenna Diameter (m)	5.60
Antenna Gain (dBi)	57.10
Antenna Elevation (Deg)	38.65
Carrier EIRP (dBW)	58.96
Power Control (dB)	0.00
Output Circuit Loss (dB)	4.00
Path Loss (dB)	207.12
Other Losses (dB)	0.70
(other loss = atm,pol,ant point)	

Receive Earth Station

Frequency (GHz)	11.95
Satellite EIRP (dBW)	50.00
Antenna Diameter (m)	1.20
Antenna Gain (dBi)	41.70
Antenna Elevation (Deg)	38.65
LNA Noise Temp (K)	75.00
Loss betw.LNA & Ant.(dB)	0.20
System Noise Temp. (K)	118.20
Station G/T (dB/K)	20.97
Path Loss (dB)	205.59
Other Losses (dB)	0.60

Interference and Thermal Contributions

C/Io Adj Sat Uplink (dB-Hz)	87.17	C/Io Intermod (dB-Hz)	81.11
C/Io Adj Sat Downlink (dB-Hz)	**77.90**	C/No Thermal Uplink (dB-Hz)	85.01
C/Io Crosspol (dB-Hz)	91.06	C/No Thermal Downlink (dB-Hz)	76.42
C/Io Adj Channel (dB-Hz)	94.67	C/Io Total (dB-Hz)	75.63
C/Io Adj Transponder (dB-Hz)	94.87	C/No Therm Total (dB-Hz)	75.86
C/Io Microwave (dB-Hz)	N/A	C/No Total (dB-Hz)	72.73

Rain Attenuation

Clear Sky Eb/No (dB)	10.85
Overall Link Margin (dB)	**5.35**
Uplink Rain Margin (dB)	5.35
Downlink Rain Margin (dB)	4.20
G/T Degradation (dB)	4.01

Transponder Operation

Number of Carriers	MULTIPLE
Total OPBO (dB)	4.00
Total IPBO (dB)	6.10
Carrier OPBO (dB)	16.96
Carrier IPBO (dB)	19.06

FCC Requirements

Uplink Flange Density (dBW/4kHz)	-24.18
Downlink EIRP Density (dBW/4kHz)	**9.00**
at 52 dBW Satellite EIRP	

Transponder Utilization

Carrier Bandwidth (MHz)	1.608
Percentage Bandwidth (%)	4.47
Percentage Power (%)	5.06

LINK BUDGET #3

Adjacent Satellites Operating at **9 dBW/4kHz** and Desired Carrier at **6 dBW/4kHz** Downlink EIRP Density

FROM: POINT A

TO: POINT B

Link Requirements	
Required Eb/No (dB)	5.50
Modulation Type	QPSK
Information Rate (Kbps)	1544.00
FEC Rate	0.69
Spread Spectrum Factor	1.44
Modem Step Size (kHz)	1.00

Satellite	
Satellite	GE-4
Satellite West Longitude	101.00
Transponder	KU
Usable Trnspndr BW (MHz)	36.00
SFD @ 0 dB/K (dBW/M^2)	-92.00
Transponder Atten (dB)	10.00
Beam Peak EIRP (dBW)	52.00

Transmit Earth Station	
Frequency (GHz)	14.25
Satellite G/T (dB/K)	5.27
Antenna Diameter (m)	5.60
Antenna Gain (dBi)	57.10
Antenna Elevation (Deg)	38.65
Carrier EIRP (dBW)	55.96
Power Control (dB)	0.00
Output Circuit Loss (dB)	4.00
Path Loss (dB)	207.12
Other Losses (dB)	0.70
(other loss = atm,pol,ant point)	

Receive Earth Station	
Frequency (GHz)	11.95
Satellite EIRP (dBW)	50.00
Antenna Diameter (m)	1.20
Antenna Gain (dBi)	41.70
Antenna Elevation (Deg)	38.65
LNA Noise Temp (K)	75.00
Loss betw.LNA & Ant.(dB)	0.20
System Noise Temp. (K)	118.20
Station G/T (dB/K)	20.97
Path Loss (dB)	205.59
Other Losses (dB)	0.60

Interference and Thermal Contributions

C/Io Adj Sat Uplink (dB-Hz)	84.17	C/Io Intermod (dB-Hz)	78.11
C/Io Adj Sat Downlink (dB-Hz)	**74.90**	C/No Thermal Uplink (dB-Hz)	82.01
C/Io Crosspol (dB-Hz)	88.06	C/No Thermal Downlink (dB-Hz)	73.42
C/Io Adj Channel (dB-Hz)	91.67	C/Io Total (dB-Hz)	72.63
C/Io Adj Transponder (dB-Hz)	91.87	C/No Therm Total (dB-Hz)	72.86
C/Io Microwave (dB-Hz)	N/A	C/No Total (dB-Hz)	69.73

Rain Attenuation	
Clear Sky Eb/No (dB)	7.85
Overall Link Margin (dB)	**2.35**
Uplink Rain Margin (dB)	2.35
Downlink Rain Margin (dB)	1.71
G/T Degradation (dB)	2.55

Transponder Operation	
Number of Carriers	MULTIPLE
Total OPBO (dB)	4.00
Total IPBO (dB)	6.10
Carrier OPBO (dB)	19.96
Carrier IPBO (dB)	22.06

FCC Requirements	
Uplink Flange Density (dBW/4kHz)	-27.18
Downlink EIRP Density (dBW/4kHz) at 52 dBW Satellite EIRP	**6.00**

Transponder Utilization	
Carrier Bandwidth (MHz)	1.608
Percentage Bandwidth (%)	4.47
Percentage Power (%)	2.54